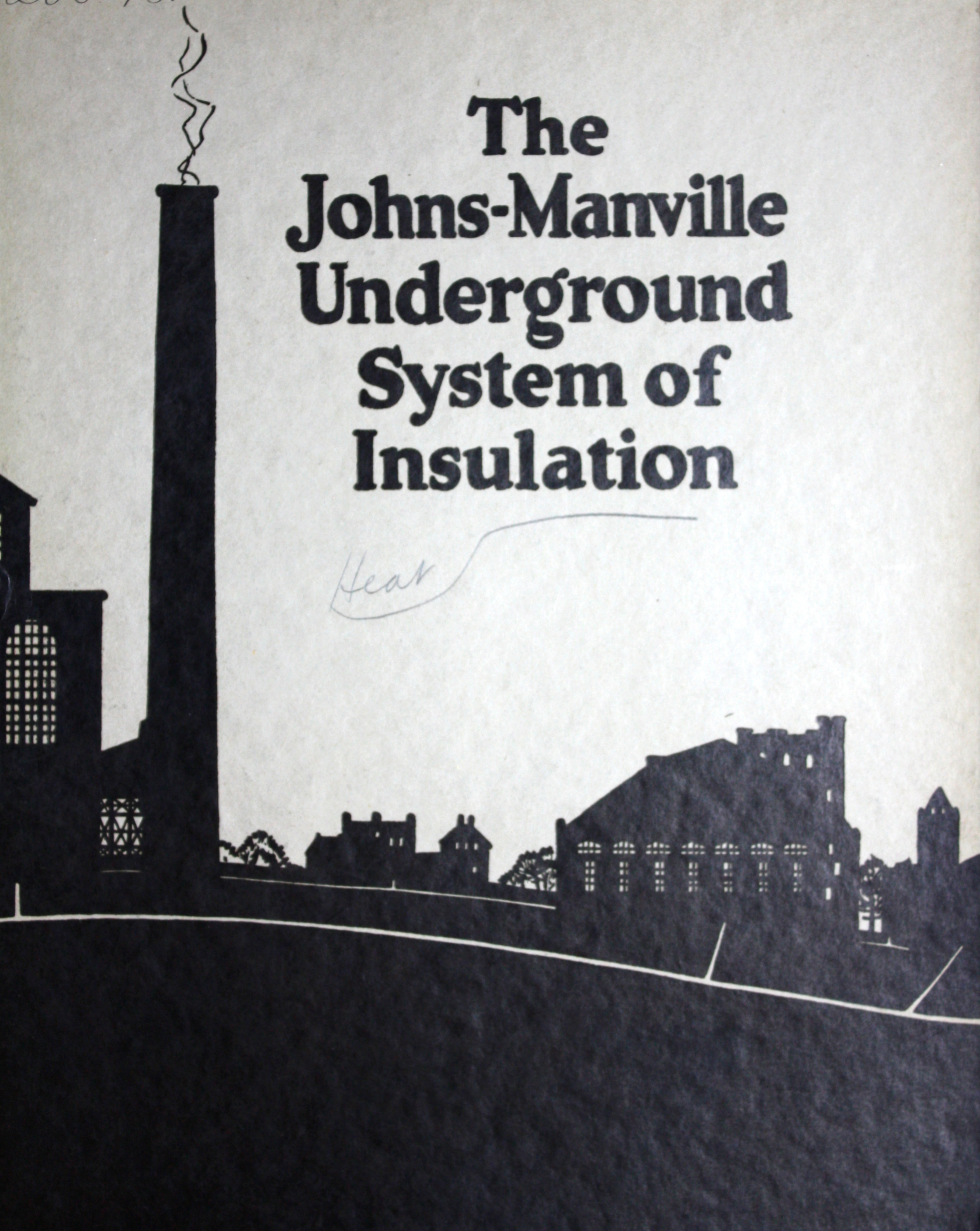
The Johns-Manville Underground System of Insulation

Heat



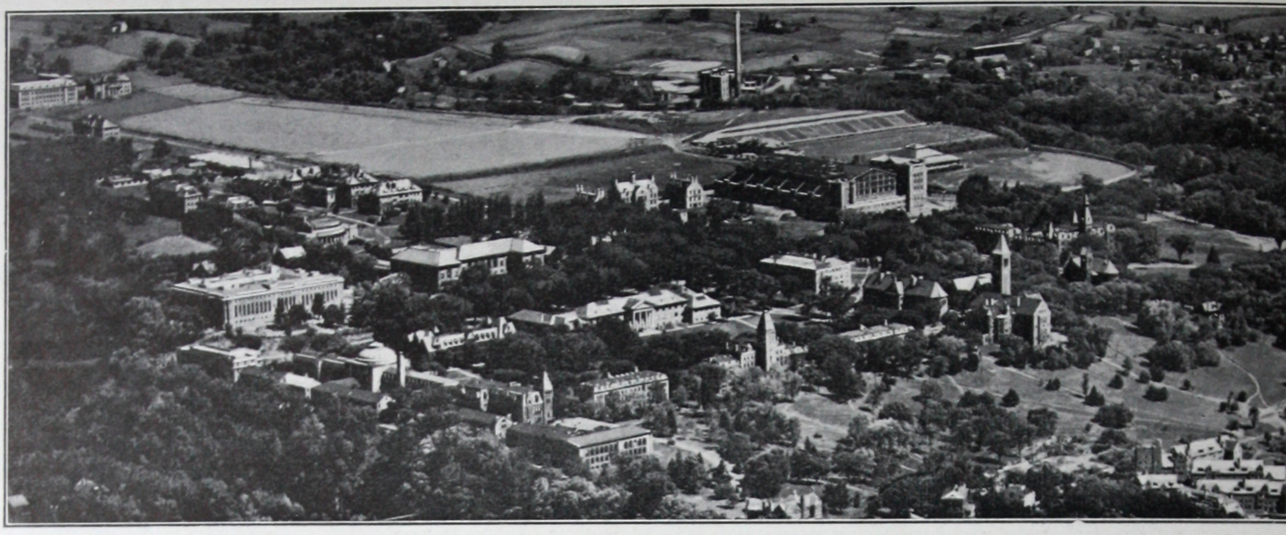
This successful installation by Johns-Manville Incorporated of an underground system of pipe insulation and distribution from a central power house demonstrates the flexibility and economy of such a system.

A
Representative Installation of the Johns-Manville Underground System of Insulation

Johns-Manville Service Covers the Continent

Through—
Asbestos
and its allied products
INSULATION
BRAKE LININGS
ROOFINGS
PACKINGS
CEMENTS
FIRE PREVENTION PRODUCTS

MCMXXIV
JOHNS-MANVILLE INCORPORATED
NEW YORK



Birdseye view of the extensive campus at Cornell University

The Johns-Manville Underground System of Insulation

THE achievement of maximum economy in central heating and power plants for the distribution of steam and hot water to building units of institutions and industrial plants has been assisted by a system of distribution, scientifically engineered and insulated according to accepted practice. This system has developed, on test, efficiencies over 90%.

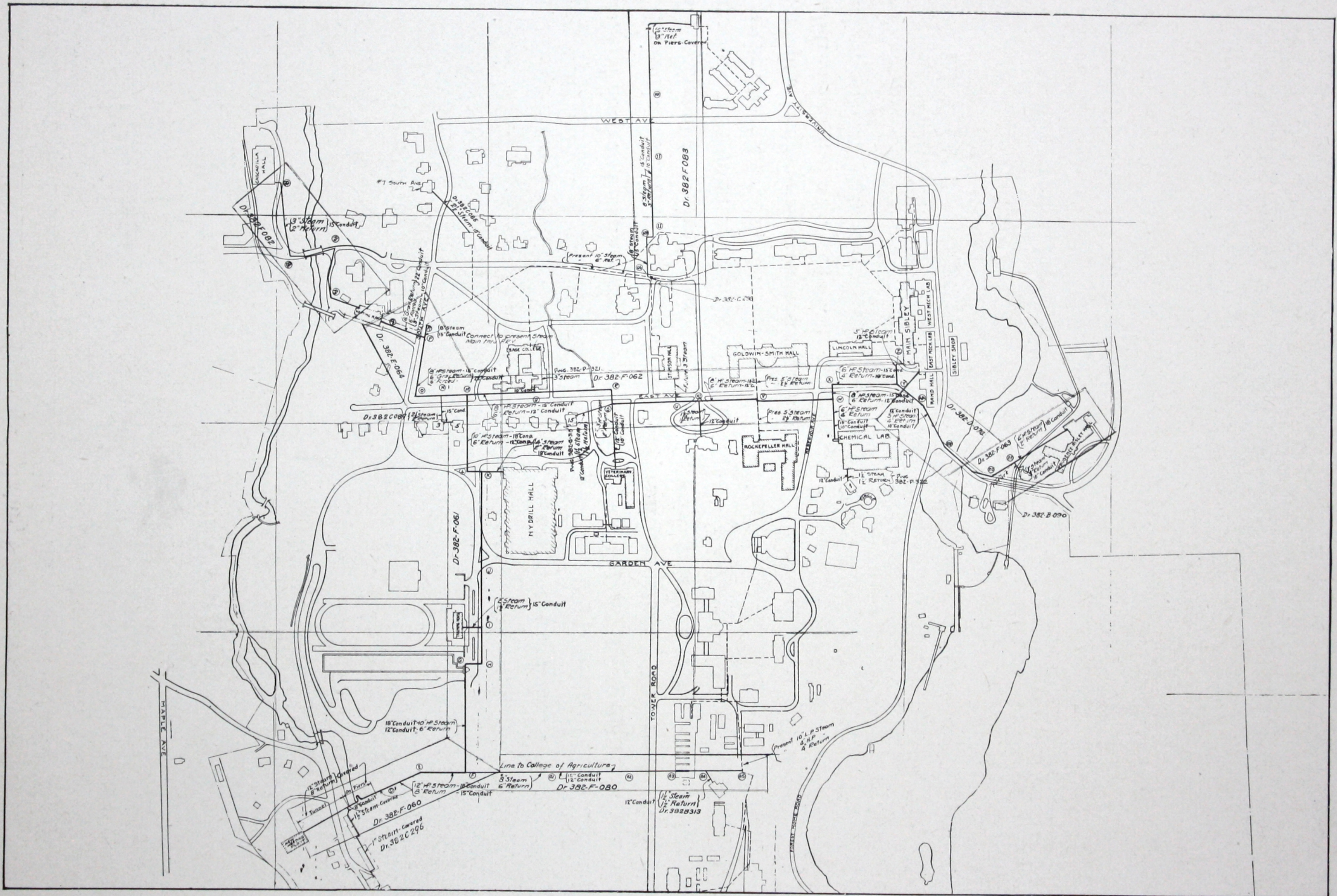
The system consists not only of the parts shown in the plate on page sixteen, such as iron roll frames, specially designed vitrified tile, Asbesto-Sponge insulation, manhole pits and other units, *but the assembling of these units into a complete system* installed by Johns-Manville Inc.

As will be later developed, the saving effected by the centralization of heating plants is further increased when the steam is distributed through the Johns-Manville Underground System of Insulation.

A few years ago the authorities of Cornell University, with the desire to heat the entire institution as economically as possible, decided to replace a number of small heating plants and low-pressure house heating boilers with one large central heating plant; and to replace numerous small concrete tunnels and other types of underground conduit with a better and more efficient system for enclosing and insulating underground steam pipes.

In preparing plans and specifications for an underground system of insulation the University authorities stipulated that the efficiency obtained upon completion must be not less than 90%. The Johns-Manville Underground System of Insulation was finally decided upon and the contract let.

The following information is given so that those considering the use of an underground system of insulation will have some idea of the various steps in its assembly



Location plan for the heat distributing system. The new heating plant is in lower left corner.

and construction and what has been accomplished through the installation of this system at Cornell:

Plans and specifications were prepared for the installation of an entirely new system. The new plant was designed for five 612 h. p. boilers to give a capacity of 5,500 b. h. p. Upon completion the loss through insulation on the steam mains was not to exceed 10% and on the return mains not more than 15% of the loss from bare pipe, based on a condensation test to be conducted when the operation was finished.

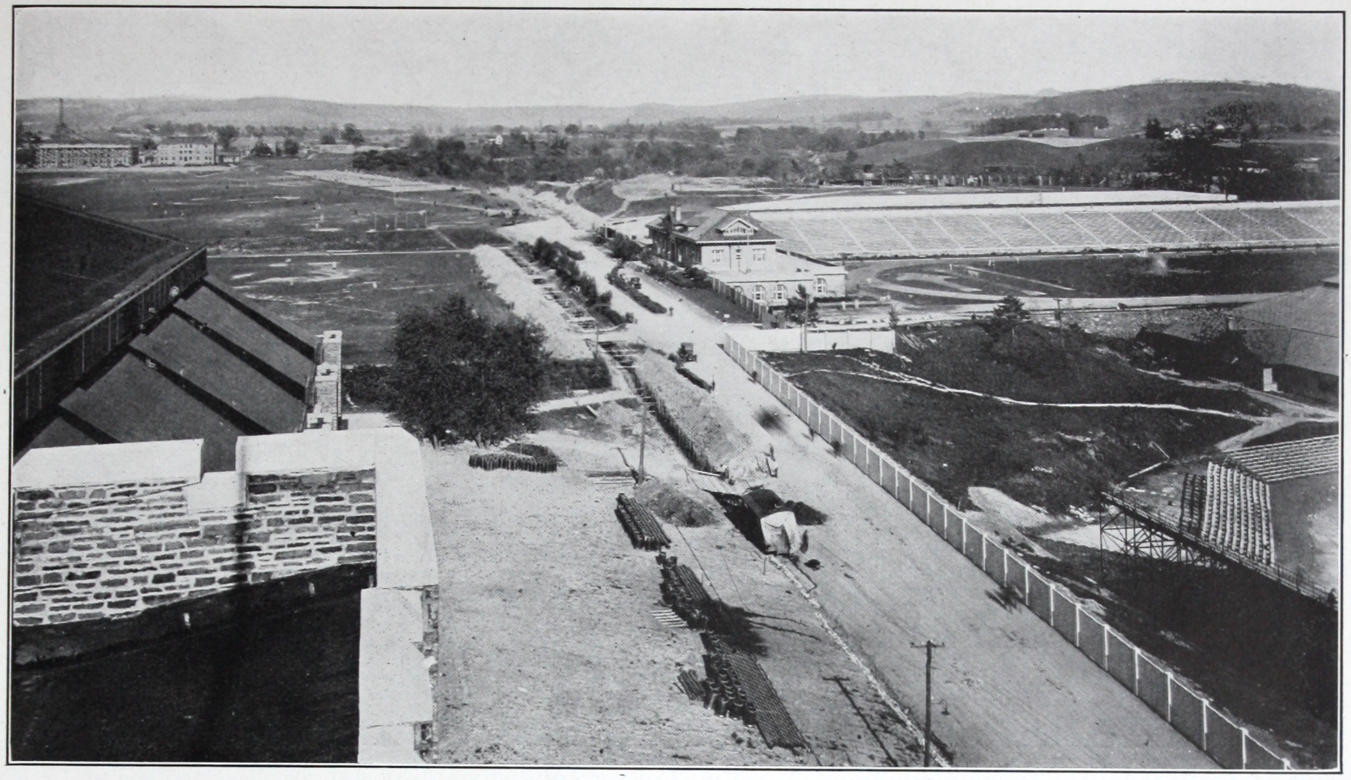
Over 19,400 feet of underground conduit lines were installed. Almost every character of ground condition was encountered, such as rock, quicksand, moisture, roads, and deep and shallow trenches.

Batter-boards were erected to insure perfect alignment, paralleling the lines from which measurements for ditching and laying the conduit were made. The bell and spigot open joint underdrains were placed in sub-trenches at the bottom of the conduit trenches. The bottom halves of the conduit were then laid on a gravel bed, and at 12-foot centers roll frames, with rollers to allow for the steam pipe expansion, were set in concrete piers. The piping was then lowered onto the roll frames and all joints welded. After the piping had been subjected to a hydrostatic test, the top sections of the tile-containing members were applied. As each successive top was set and cemented in place the entire space between the steam piping and the container was filled with Johns-Manville Asbesto-Sponge Conduit Filling. All joints were waterproofed with Johns-Manville Asphalt Roof Coating. The gravel bed was then brought up above the side joints of the tile-containing members and the trench backfilled to grade.

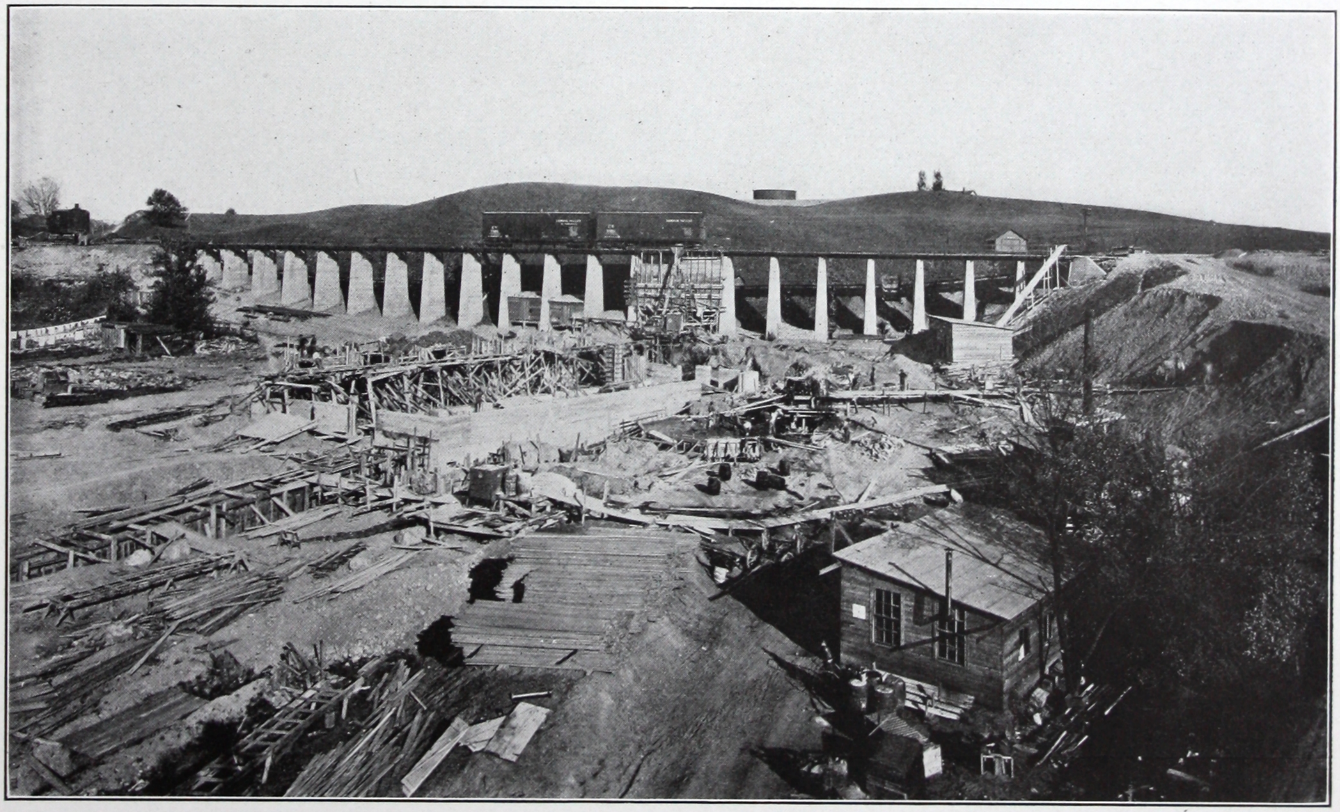
The underground work on the main contract was completed September, 1922.

The condensation test to determine the efficiency of the installation was made 13 months later. The results are given on page fourteen.

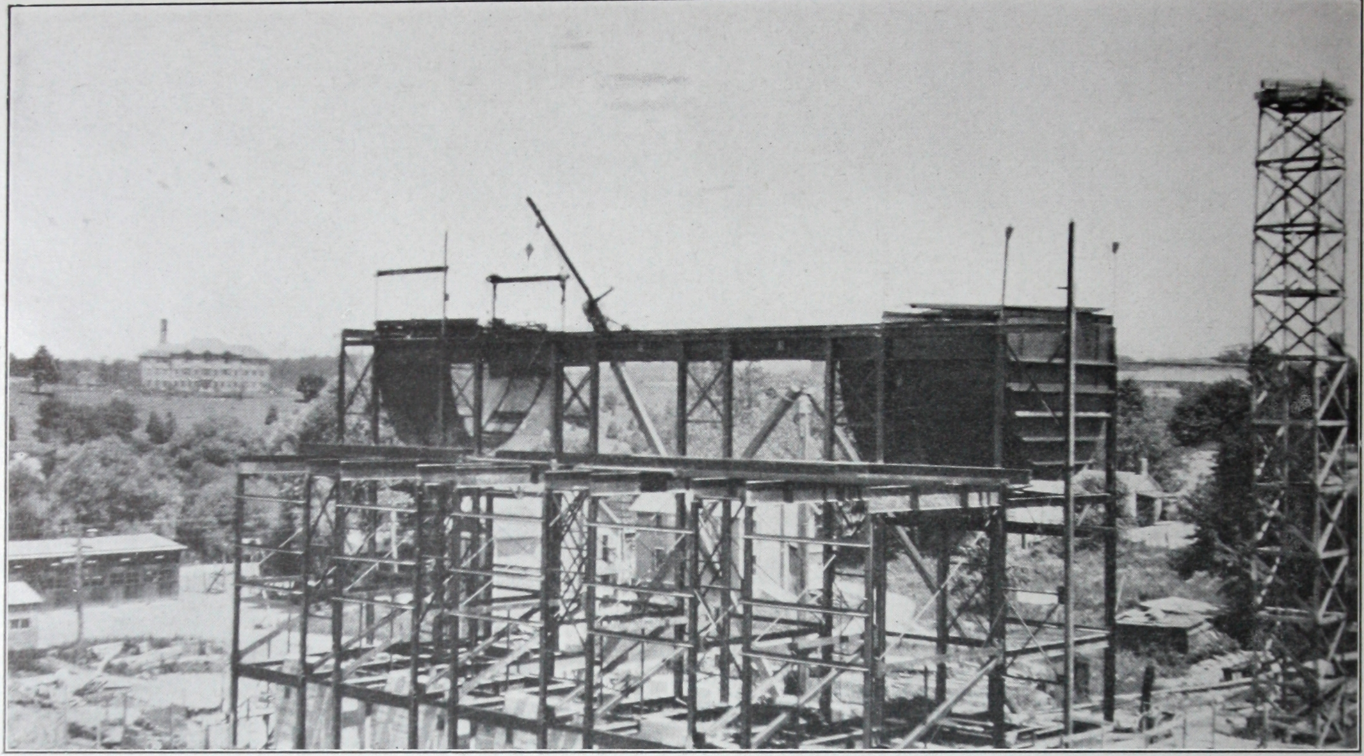
Johns-Manville Inc. takes pride in the list of representative installations on pages eighteen, nineteen and twenty. It will be noted that some of the foremost institutions and industrial plants of the country are represented. They stand as permanent testimonials to the Johns-Manville Underground System of Insulation.



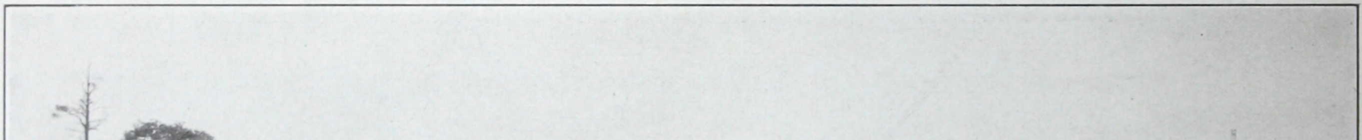
Main thoroughfare between athletic field and drill hall. Agricultural buildings are seen in background. All are heated by the new plant and system. In the center foreground, trenching machine is shown digging trench for Johns-Manville Underground System of Insulation.



Heating plant site; coal trestle and foundation walls erected. Forms for tunnel from heating plant to creek are shown near shack on the right. Foundation for heating plant in center.

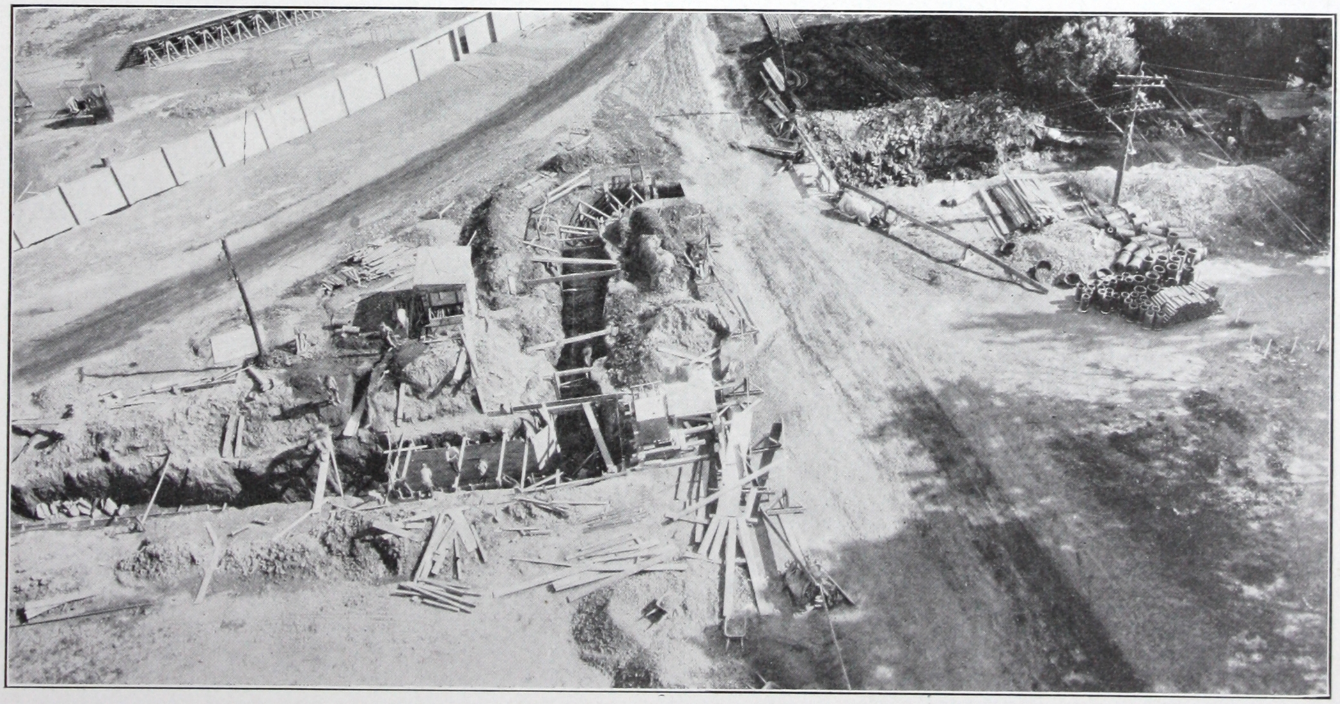


Showing the steel work and coal bunkers for power plant in place.



Creek from which make-up water is pumped to heating plant—a distance of about 100 feet. Tunnel excavation is seen near frame building at right. The 12-inch steam and 8-inch return mains are run through this tunnel thence overhead across the stream and on piers, carrying the expansion bend, to a point beyond the trees where they again enter the ground.

Showing boom and bucket of trenching machine loading truck with dirt. Excavation in the foreground is for a large expansion manhole. Conduit lines from heating plant run through trench in which men are working. This also shows another ground condition encountered.



Conduit trench and large double offset expansion loop chamber being sunk near the athletic field. Trench is shown in immediate foreground. At right are materials awaiting installation.

One of the numerous difficult conditions encountered. Many springs and some quicksand gave considerable trouble during ditching work. The trench varied in depth from 3 to 25 feet.

The mechanic is laying the underdrain in the sub trench made for this purpose. Two underdrains are laid because of two runs of conduit. Grades are established by measuring downward from the overhead parallel batter-boards.

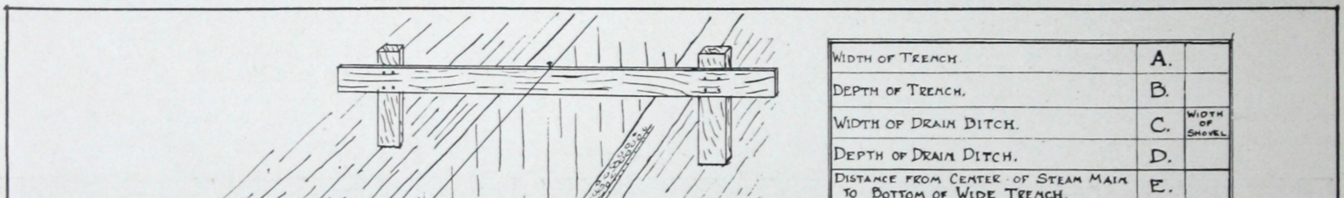
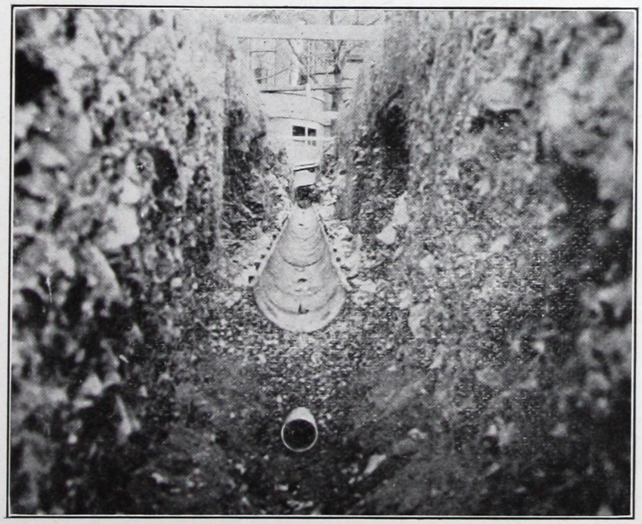


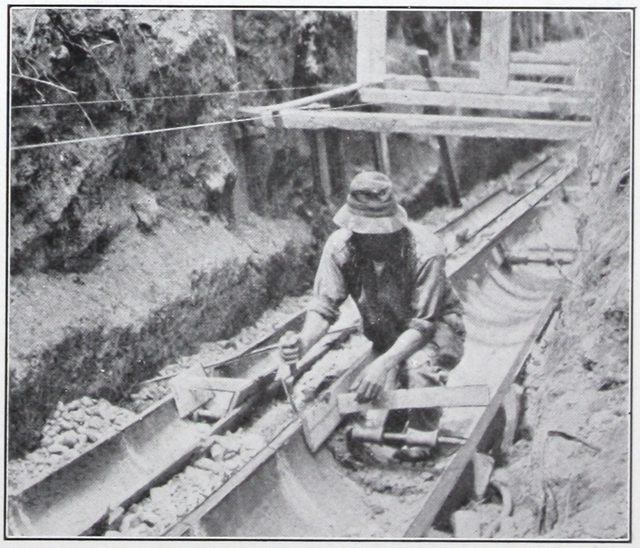
Diagram showing construction details of the system.

Showing the lower half of the conduit being laid, the mechanic measuring for proper grade from line above. Note that conduit is laid in gravel through which rain or spring water rapidly percolates to the underdrain.

Centering lower half of conduit by means of a suspended plumb-bob. The iron pipe standing against trench to the left of the mechanic is used to ram gravel under the conduit thus providing a substantial bed.



Detail showing conduit entering through building foundation, trench, underdrain, gravel bed and bottom half of conduit. Note perfect alignment of the line.



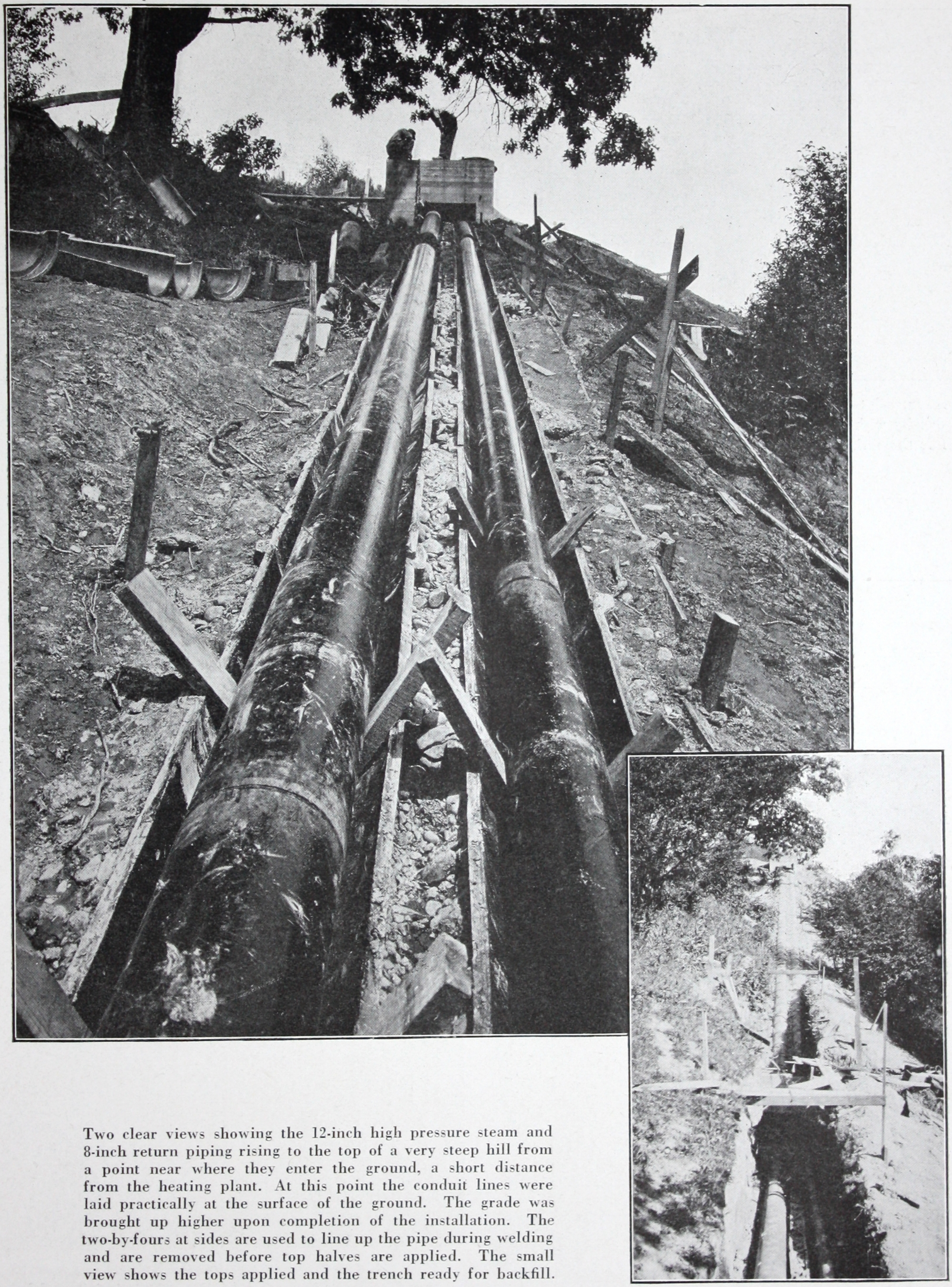
Mechanic setting roll frames in concrete piers. These frames support the piping.

This is the way roll frames are set to proper elevation. Measurements are made for all units in the Johns-Manville System by measuring from the overhead line to the unit being installed.

Installation showing Johns-Manville four roll frame unit. This type provides for double-deck construction.

Piping being installed on roll frames. Joints are being welded. An 8-inch steam line and two 6-inch return lines are shown. Expansion chamber in background.

Conduit tops being applied. The upper and lower halves are numbered so they can be properly mated. Conduit filling is seen beneath the piping.



Two clear views showing the 12-inch high pressure steam and 8-inch return piping rising to the top of a very steep hill from a point near where they enter the ground, a short distance from the heating plant. At this point the conduit lines were laid practically at the surface of the ground. The grade was brought up higher upon completion of the installation. The two-by-fours at sides are used to line up the pipe during welding and are removed before top halves are applied. The small view shows the tops applied and the trench ready for backfill.

After each top is set, the space between it and the pipe is rammed to proper density with Johns-Manville Asbesto-Sponge Conduit Filling. This method fills the entire conduit and thus prevents air circulation.

After a number of top halves are applied the bell joints are thoroughly cemented.

Mechanics waterproofing exposed cement surfaces.

Next to the last operation. Placing additional gravel in trench to bring it above side-joints. This is followed by backfilling and grading.

Double run of completed conduit ready for waterproofing, additional gravel and backfill. This run is under a roadway between Drill Hall and Athletic Field. The picture on page five shows this during construction.

Condensation Test

92.77% efficiency shown at Cornell University

THE test to determine the efficiency of the installation was conducted by William M. Sawdon, Professor of Experimental Engineering at Cornell University. The owner provided and installed proper steam connections with stop valve, steam calorimeter and connections for pressure gauge and thermometers to measure the temperature of the steam; suitable arrangements for collecting condensation; and thermometers for taking soil temperatures.

The purpose of this test was to prove the guarantee which the specification stated as follows:

Loss of heat from steam pipes under test shall not exceed 10% of what the loss would be in a corresponding bare pipe exposed in still air where the temperature of the air is the same as that of the ground. The loss of heat from bare pipe in still air shall be figured according to a curve plotted to the following:

Temp. diff. deg. Fahr. between pipe and still air	Heat loss in B.t.u. per sq. ft. of exterior pipe area per deg. Fahr. temp. diff. per hr.
50	1.95
100	2.152
150	2.4
200	2.665
250	2.951
300	3.26
350	3.627
400	4.035
450	4.557
500	5.18

The test was conducted on the major portion of the steam line running from manholes F to M, M to P1 and M to BB (see plot plan, page 3) which consisted of the following insulated pipe in conduit and manholes:

1832 ft. of 10″ pipe in 18″ conduit 72 ft. of 10″ pipe in manholes ..	Stations F to M
2316 ft. of 8″ pipe in 15″ conduit 149 ft. of 8″ pipe in manholes ..	Stations P1 to X
434 ft. of 6″ pipe in 15″ conduit 4 ft. of 6″ pipe in manholes .. 10 ft. of 5″ pipe in manholes ..	Stations X to AA
227 ft. of 5″ pipe in 12″ conduit 3 ft. of 5″ pipe in manholes ..	Stations AA to BB

5047 ft. total length of pipe in conduit and manholes under test, exclusive of fittings and expansion joints which were also included in test.

The test in general consisted of supplying steam to the portion of the line under test, which was closed off from the remainder of the system, and collecting and weighing the water of condensation at three low points in the line. The pressure on the test line was maintained constant through a pressure-reducing valve. Periodic readings were taken of the pressure and the quality of the steam supplied. Half-hourly readings were taken of the temperatures in all manholes, at five points in the ground, and of the outside air. Every precaution was taken to secure accurate, simultaneous readings at all stations. The test was complete when constant readings had been obtained over a period of six hours.

The following tabulation gives a summary of the data, and results obtained from the test:

Data

Date of test	October 7, 1923
Weather	Clear
Duration of test	6 hours
Barometer pressure	29.52 inches
Average temperature outdoors	55 deg. Fahr.
Average temperature in manholes	124 deg. Fahr.
Average temperature of ground 50 feet or more from conduit	58 deg. Fahr.
Average steam pressure, gauge	139.0 lbs.
Average steam pressure, absolute	153.5 lbs.
Average steam temperature	360 deg. Fahr.
Average quality of steam supplied	98.9%
Total weight of condensate collected per hour	1327.5 lbs.
Weight of steam condensed per hour	1312.9 lbs.
Latent heat of 1 lb. steam at 153.5 lbs. pressure	861.7 B. t. u.
Difference in temperature between steam in pipe and surrounding earth	302 deg. Fahr.
Area of insulated pipe between manholes	11,470.8 sq. ft.
Area of insulated pipe and fittings in manholes	1,006.8 sq. ft.
Total area of insulated pipe and fittings	12,477.6 sq. ft.
Area of bare pipe and fittings in manholes	387.7 sq. ft.

Results

Heat loss per hour equivalent to steam condensed	1,131,500 B. t. u.
Heat loss per hour by bare surfaces in manholes	262,660 B. t. u.
Net heat loss per hour from insulated surfaces under test	868,840 B. t. u.

Calculated heat loss per hour from equivalent bare surface in still air:—

Insulated pipe between manholes	11,327,870 B. t. u.
Insulated pipe and fittings in manholes	694,640 B. t. u.
Total heat loss per hour from equivalent bare surface in still air	12,022,510 B. t. u.
Net heat loss per hour from insulated surfaces (see result col.)	868,840 B. t. u.
Heat saving per hour =	11,153,670 B. t. u.

$$\text{Efficiency} = \frac{\text{Heat saved per hour by insulation}}{\text{Heat loss per hour from equivalent bare surface in still air.}}$$

$$= \frac{11,153,670}{12,022,510} \times 100\% = 92.77\%$$

$$\text{Heat Loss} = 100\% - 92.77\% = 7.23\%$$

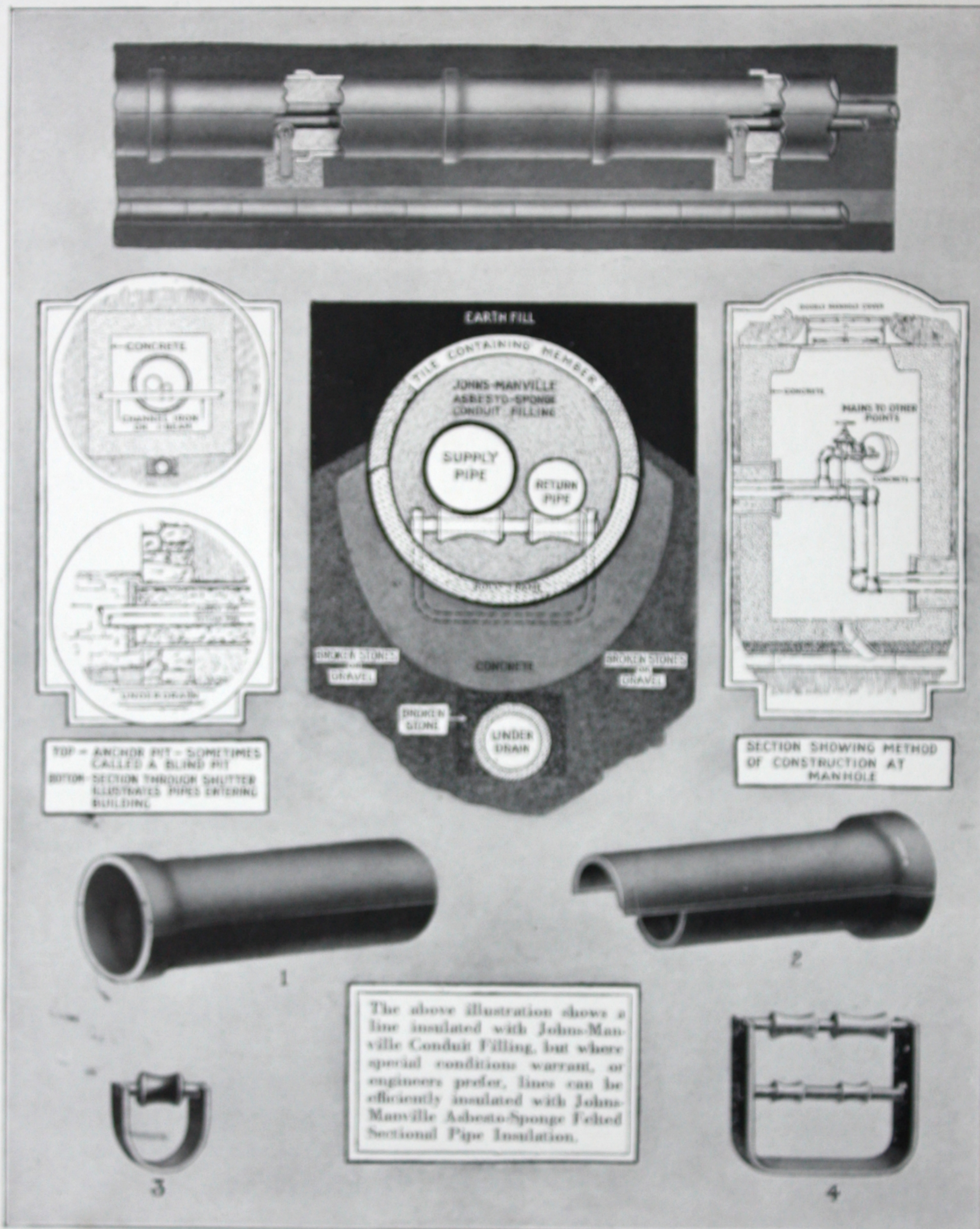
Conclusions

This test proved that the Johns-Manville Underground System of Insulation (consisting of insulated piping and fittings in conduit and manholes) *exceeded the guarantee, in that the heat loss was only 7.23% of the bare pipe loss, whereas the specification allowed a loss of 10%.* This means that the actual loss from the Underground System of Insulation which had been installed for 13 months, and in operation for the greater part of that time, was 2.77% lower than the loss allowed by the guarantee. This represents an *additional* saving of 85 tons of coal annually over and above the guaranteed saving *on the tested portion alone* (based on operation eight months of the year).

The plant is now operating for its second successful heating season and is reported as giving entirely satisfactory results.

As all the materials used for insulating purposes in this installation, and the waterproof envelope protecting the insulation, i.e. tile, asbestos and iron roll frames, are practically indestructible, the high insulating efficiency will, with little attention, be maintained during the life of the system.

Integral parts of the Johns-Manville System



The integral parts of the Johns-Manville Underground System of Insulation: 1—straight section; 2—supporting section; 3—one-roll frame; 4—four-roll frame.

Description of the Johns-Manville System

THE Johns-Manville Underground System of Insulation provides a permanent, efficient and economical means of placing underground and insulating pipes conveying steam or hot water.

The system comprises not only the integral parts shown on the opposite page, but the proper selection and arrangement of these parts and the installation or supervision of installation of them by Johns-Manville engineers.

The average efficiency of the Johns-Manville System is at least 90% when installed according to our specifications and by us or under our supervision. This high efficiency is maintained for a long period of time on account of the character of the materials used in construction.

The high and lasting heat insulating efficiency of Johns-Manville Asbesto-Sponge Filling is due to the many "dead air" spaces and cells which it confines, and to its base of indestructible asbestos fibre. When packed around the pipe to be insulated, it completely fills the space inside of the protecting and containing members of the system. It is extremely resilient and spongy, so that there is little tendency for it to settle.

The Johns-Manville Supporting Roll Frame has been designed to provide support for the pipes and to insure that they may move freely when expanding and contracting.

The Supporting Section of the system is a most important part as it completely covers and encloses the roll frames and also acts as a connecting link between the containing sections.

The supporting sections are connected by Containing Sections, which complete the continuous stone protective member which surrounds the entire system and acts as a container for the Asbesto-Sponge Filling.

The sections are split diagonally, so that the lateral joints will shed water better than if the cut of the joint were straight, and each half of every section is numbered so that in the installation of the system mates of each section will always be placed together.

Provision is made to prevent water from accumulating around the system and to drain or carry it away by the use of an Underdrain of small tile pipe laid with open joints and embedded in crushed stone, which is carried up and around the system to a point above the lateral joints.

Wherever there may be valves, expansion joints, flanged joints, or other features which it may be desirable or necessary to reach occasionally, and which cannot be placed in a building into which the system runs, a manhole with a removable but water-tight cover should be employed.

Berea College and Allied Schools

Heat and Power Plant
George G. Dick, Supt.

Berea, Ky., May 16, 1924.

Johns-Manville Inc.,
New York City.

Gentlemen:—

The other day we had occasion to make a steam tap in one of our low pressure steam conduit mains. This conduit line, which is made of Johns-Manville sectional conduit and filled with your Asbesto-Sponge filler, was installed 20 years ago and you will be interested to know that the Asbesto-Sponge filler had not settled over one-quarter of an inch, was perfectly dry, and seemingly in as good condition as it was the day we installed it. The pipes are also in fine condition.

We have not spent a penny on this underground steam main for repairs during these 20 years. We anticipate many more years of service from this, our oldest steam conduit line.

The line was put in under the supervision of the R. D. Kimball Company of New York City.

We are glad to be able to send you such a favorable report and believe you will be glad to know these facts.

Very truly yours,

(signed) Geo. G. Dick.

Representative Installations

ALABAMA

West Point Mfg. Co. . . . . Fairfax
Boys School . . . . East Lake
Alabama Masonic Home . . . . Montgomery

ALASKA

Alaskan Engineering Commission . . . . Anchorage

ARKANSAS

State Agricultural School . . . . Russellville

CALIFORNIA

Danziger residence . . . . Beverly Hills
Civic Center. . . . . San Francisco
Stanford Jr. University . . . . Stanford

CANADA

McGill University . . . . Montreal, Que.
Canadian Pacific Railway . . . . Montreal, Que.
Canadian Products, Ltd. . . . . . . Windsor, Ont.
Canadian Sugar Refining Co., Ltd. . . Montreal, Que.
Imperial Tobacco Co. . . . . Montreal, Que.
Imperial Tobacco Co. . . . . Granby, Que.
St. Maurice Pulp and Paper Co. . Three Rivers, Que.
Normal School . . . . Granby, Que.
General Motors . . . . Oshawa

COLORADO

Colorado Springs Elec. Co. . . . . Colorado Springs
United Service Co. . . . . Colorado Springs
Pueblo Elec. Co. . . . . Pueblo

CONNECTICUT

Hartford Retreat . . . . Hartford
Pratt & Whitney . . . . Hartford
Waterbury Hospital . . . . Waterbury
Westover School . . . . Middlebury
Torrington Hospital . . . . Torrington
Edward Malley . . . . New Haven
Norwich Insane Hospital . . . . Norwich
Scoville Mfg. Co. . . . . Waterbury
Thread Agency . . . . Willimantic
Wesleyan University . . . . Middletown
Connecticut School for Feeble Minded . . Mansfield
Connecticut Colony for Epileptics . . . . Mansfield
Taft School . . . . Watertown
American Brass Co. . . . . Ansonia
Wm. Ziegler residence . . . . Noroton
American Brass Co. . . . . Waterbury
Franklin S. Jerome residence . . . . . Greenwich

DELAWARE

American Vulcanized Fibre Co. . . . . . . Newark
Winterthur Farms . . . . Winterthur

DISTRICT OF COLUMBIA

U. S. Dept. of Agriculture . . . . . . Washington

FLORIDA

Florida East Coast Hotel . . . . Palm Beach

GEORGIA

Atlanta Baptist College . . . . Atlanta
State Agricultural School . . . . Athens

IDAHO

Oregon Short Line Ry. . . . . Pocatello

ILLINOIS

Bolton Bros. Electric Co. . . . . Aledo
Liquid Carbonic Co. . . . . Chicago
University of Illinois . . . . Champaign
American Bridge & Iron Co. . . . . Chicago
Illinois Malleable Iron Co. . . . . Chicago
Lincoln Park . . . . Chicago
Municipal Tuberculosis Sanitarium. . . . . Chicago
Star Mfg. Co. . . . . Carpentersville
Elgin, Joliet & Eastern R. R. . . . . . . East Joliet
N. Y. C. R. R. Company . . . . Englewood
Residence of Mrs. C. H. McCormick . . Lake Forest
Barber Coleman Co. . . . . Rockford
St. Charles School for Boys . . . . . St. Charles
Southern Illinois State Normal School . Carbondale

INDIANA

Northern Ind. Hospital for the Insane . . Long Cliff
Oliver Chilled Plow Co. . . . . South Bend
Dodge Mfg. Co. . . . . Mishawaka
M. Rumely Co. . . . . La Porte
Notre Dame University . . . . South Bend
Studebaker Co. . . . . South Bend
Lake Shore & Michigan Southern Ry. . South Bend
Claypool Hotel Co. . . . . Indianapolis
St. Joseph's College . . . . Rensselaer
Republic Iron & Steel Co. . . . . . . East Chicago
Western Drop Forge Co. . . . . Marion
City Water & Electric Co. . . . . Mishawaka
La Porte Gas & Electric Co. . . . . La Porte
Marion Branch, N. H. D. V. S. . . . . Marion

IOWA

Iowa College . . . . Grinnell
Municipal Electric Light, Heat &
Power Co. . . . . Ackley
G. E. Reed . . . . Davenport
Carr-Ryder Adams Co. . . . . Dubuque
People's Gas & Electric Co. . . . . . . Mason City

KENTUCKY

Berea College . . . . Berea
Western Kentucky Asylum for Insane . Hopkinsville

KANSAS

Washburn College . . . . Topeka

MAINE

University of Maine . . . . Orono
Grand Trunk Railway . . . . .Portland

MASSACHUSETTS

International Y. M. C. A. College . . . .Springfield
Amherst College. . . . . .Amherst
Mt. Holyoke College . . . . .So. Hadley
Groton School. . . . . Groton
Mass. Agricultural College . . . . Amherst
Mt. Hermon School . . . . Mt. Hermon
Northfield Seminary . . . . Northfield
Phillips Academy . . . . .Andover
Abbot Academy . . . . .Andover
Wellesley College . . . . Wellesley
Williams College . . . . Williamstown
Charles River Basin Co. . . . . .Cambridge
Vacuum Oil Co. . . . . East Cambridge
Middlesex School . . . . Concord
Boston State Hospital . . . . .Dorchester
Grafton State Hospital . . . . Grafton
Newton Theological Seminary. . . . . . . Newton
Holy Cross College. . . . . Worcester
St. Michael's Cathedral and School
Association . . . . .Springfield
Wheaton College. . . . . Norton
Mass. Hospital for Epileptics . . . . Palmer
Danvers Insane Asylum. . . . . Danvers
Mary McClellan Hospital . . . . .Cambridge

MICHIGAN

Lake Superior Steam Heating Co. . . Iron Mountain
Detroit United Railways Co. . . . . Detroit
Battle Creek Sanitarium . . . . Battle Creek

MINNESOTA

Alexandria Heating Co.. . . . . .Alexandria
City of Buhl Municipal Buildings . . . . . . Buhl

MONTANA

Montana State Hospital for the
Insane . . . . Warm Springs
State Agricultural School . . . . Bozeman
Bozeman University . . . . Bozeman
House of the Good Shepherd . . . . . . Helena
State Hospital . . . . Warm Springs

NEW HAMPSHIRE

New Hampshire College . . . . Durham
Dartmouth College. . . . . Hanover
Phillips Exeter Academy . . . . .Exeter
Proctor Academy . . . . Andover
City of Franklin Municipal Buildings . . . Franklin

NEW JERSEY

E. R. Squibb & Co.. . . . . New Brunswick
P. Ballantine & Co.. . . . . Newark
Jacques Wolf & Co.. . . . . Passaic
Celluloid Co. . . . . Newark
Public Service Corporation . . . . Newark
Monmouth Memorial Hospital. . . . .Long Branch
Montclair School . . . . Montclair
Estate of H. McK. Twombly. . . . . Madison
New Jersey State Home for Girls. . . . . . Trenton
U. S. Govt. Proving Grounds . . . . . Sandy Hook
Eastwood Wire Mfg. Co. . . . . Belleville
Eastern Coal Dock Co. . . . . South Amboy
Manhattan Rubber Mfg. Co. . . . . Passaic
Long Branch School . . . . .Long Branch
Baker Castor Oil Co. . . . . Jersey City
Morris Avenue School . . . . .Long Branch
Tuberculosis Preventorium . . . . . . Farmingdale
Boonton Rubber Co. . . . . Boonton
Montclair Normal School . . . . Montclair
Singer Mfg. Co. . . . . Elizabethport
Standard Underground Cable Co. . . Perth Amboy
Merck & Co.. . . . . Rahway
Stevens Institute of Technology . . . . . .Hoboken
St. Mary's Hospital. . . . . Orange
Drew Theological Seminary. . . . . Madison
East Orange High School. . . . . Orange
St. Joseph's Hospital . . . . .Paterson

NORTH CAROLINA

A. & M. College . . . . Raleigh

NEW YORK

Municipal and County Buildings. . . New York City
Metropolitan Hospital . Blackwell's Island, N. Y. C.
U. S. Navy Yard . . . . Brooklyn
Union College . . . . Schenectady
General Electric Co. . . . . Schenectady
Manhattan State Hospital . . Ward's Island, N. Y. C
U. S. Government Arsenal. . . . . Watervliet
H. L. Pratt residence . . . . Glen Cove
Masonic Home. . . . . Utica
N. Y. Orthopaedic Hospital . . . . . .White Plains
Niagara Falls High School . . . . . Niagara Falls
Fordham Hospital . . . . New York City
Burke Relief Foundation . . . . .White Plains
H. W. Boettger residence . . . . Riverdale
Metropolitan Life Insurance Co.. . . Mt. McGregor
Mrs. Gordon K. Bell residence . . . . Katonah
Borden's Condensed Milk Co.. . . . . . . .Brewster
Long Island State Hospital . . . . Brooklyn
Fredonia Normal School . . . . Fredonia
Jacob Zoller Co. . . . . .Little Falls
Troy Orphan Asylum. . . . . Troy
Central Union Gas Co. . . . . New York City
Weber Electric Co.. . . . . Schenectady
C. O'D. Iselin . . . . New Rochelle
Lawrence Park Light, Heat & Power
Company . . . . Bronxville
Hebrew Sheltering Society . . . . . . Pleasantville
The Castle School . . . . Tarrytown
Colgate University . . . . Hamilton

Continued on next page

NEW YORK—*Continued*

Wells College . . . . Aurora
University of Rochester. . . . . Rochester
Bloomingdale Hospital . . . . .White Plains
New York State Reform School for Girls . . . . Bedford Hills
New York State Agricultural College . . . . Farmingdale, L. I.
New York State Hospital . . . . Gowanda
New York State School for Girls. . . . . . Hudson
St. Stephen's College . . . . Anandale
Letchworth Village . . . . Thiells
Central Islip State Hospital. . . . . . Central Islip
City Farm Colony . . . . .Staten Island
Louis C. Tiffany residence . . . . .Oyster Bay
Cathedral of St. John the Divine . . New York City
Mrs. Whitelaw Reid residence . . . . .White Plains
Samaritan Hospital . . . . Troy
Astoria Light, Heat & Power Co.. . . . Astoria, L. I.
General Vehicle Co. . . . . Long Island City
St. Lawrence State Hospital. . . . . . Ogdensburg
Faxton Hospital . . . . Utica
New York Public Library. . . . . . New York City
New York State Soldiers' Home. . . . . . . Bath
Lakeside School . . . . Spring Valley
Vassar College. . . . . Poughkeepsie
Vassar Brothers Hospital . . . . . . Poughkeepsie
Cornell University . . . . .Ithaca
Wingdale Prison. . . . . Wingdale
Halcomb Steel Co. . . . . .Syracuse
Sing Sing Prison . . . . Ossining
Capt. De Lemar residence . . . . . Glen Cove, L. I.
Utica Knitting Co. . . . . Utica
E. F. Albee residence . . . . .Larchmont
Jewish Pro. Aid Society . . . . .Hawthorne

OHIO

People's Light, Heat & Power Co. . . . Springfield
City of Cleveland . . . . Brookside Park
Corrigan, McKinney & Co. . . . . Cleveland
Oberlin College . . . . Oberlin
Institute for Feeble Minded . . . . Morgens
Ohio Cultivating Co. . . . . Bellevue
Cleveland Foundry Co. . . . . Cleveland
American Textile Co. . . . . Greenfield
Cuyahoga County Court House . . . . . Cleveland
City of Cleveland . . . . Cleveland
Western Automatic Machine Screw Co.. . . . Elyria
Toledo Furnace Co. . . . . Toledo

PENNSYLVANIA

United Gas Improvement Co. . . . . . Philadelphia
Wayne Elec. Light & Steam Heat Co. . . . .Wayne
Penn. Institution for the Deaf and Dumb. .Mt. Airy
Vanadium Hotel. . . . . Cambridge Springs
White Haven Sanitarium . . . . . . White Haven
Muhlenberg College . . . . Allentown
Presbyterian Home . . . . .Bala
Church of the Redeemer . . . . Bryn Mawr
Lafayette College . . . . .Easton
Elliot Co. . . . . Jeannette
Pennsylvania Reform School . . . . . . Morganza
Church of Gesu . . . . Philadelphia
Church of Nativity. . . . . Philadelphia
Elizabeth Steel Magee Hospital . . . . . Pittsburgh
P. H. Glatfelter . . . . .Spring Grove
Swarthmore College . . . . Swarthmore
Central Station for the Town of Windber. . . . . .Windber
State Normal School . . . . Indiana

RHODE ISLAND

St. Mary's Church Parish . . . . .Providence
The Brown & Sharp Mfg. Co. . . . . . .Providence
R. I. School for Feeble Minded . . . . . . .Exeter
State Hospital . . . . Howard
Church of Our Lady of Good Counsel . . . Phoenix

SOUTH DAKOTA

State School of Mines . . . . .Rapid City
Mobridge Electric Light, Power and Heating Co. . . . . Mobridge

TENNESSEE

University of Tennessee . . . . Chattanooga
Nashville Gas and Heating Co. . . . . . Nashville

UTAH

Oregon Short Line. . . . . Salt Lake City

VERMONT

Middlebury College . . . . Middlebury
Vermont Hospital for Insane . . . . . . Waterbury
Brattleboro Retreat . . . . Brattleboro

VIRGINIA

A. J. Kennard . . . . .Roanoke
Hampton Normal & Agricultural Institute. . . . . Hampton

WASHINGTON

University of Washington. . . . . .Seattle
Tacoma Gas Co. . . . . Tacoma

WEST VIRGINIA

West Virginia Wesleyan College. . . . Buckhannon
West Virginia Colored Institute . . . . . . Institute
University of West Virginia. . . . . . . Morgantown
Welch Miners Hospital. . . . . Welch
Eagle Glass & Mfg. Co. . . . . Wellsburg

WISCONSIN

Chicago Brass Co. . . . . Kenosha
Dodge County Insane Asylum . . . . Junea
Milwaukee County Almshouse . . . . Wauwautosa
Wisconsin Condensed Milk Co. . . . . Burlington
Cedar Island Lodge . . . . . . .Lake Nebagamon
St. Francis Seminary . . . . .St. Francis
Kempsmith Mfg. Co.. . . . . West Allis
St. Johns R. C. Church . . . . .Jefferson

WYOMING

University of Wyoming. . . . . Laramie

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